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ENGINEERING IN AN AMERICAN PROGRAM FOR SOCIAL PROGRESS[1]

By Dr. KARL T. COMPTON

PRESIDENT OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

IT is a great pleasure for me, on this notable occasion, to bring you the congratulations of your sister institution which I serve and to express the cordial best wishes for the even greater success of your engineering school in the next twenty-five years, which is the confident hope of your thousands of colleagues in sister educational institutions and in the engineering profession.

The Johns Hopkins University has been a pioneer and an example in much of the finest development of education in America, notably in such fields as chemistry, physics and medicine, and in postgraduate education. It attained this preeminence through concentration of its resources in a limited number of basically important fields, instead of dissipating its energies in an attempt to spread thinly over the whole field of knowledge or to pursue the ever appearing will-o-the-wisps of educational fashions. Its School of Engineering, though one of its younger departments, is of this basic character and has achieved distinction through the high ability and character of its staff and through its policy also of limiting its range of activities to those fundamental fields of engineering which it can cultivate with distinction within the limitations of its resources. While we all hope that ways and means may be found to increase its resources commensurately with its proven worth and opportunities, I trust that its wise policy of subordinating expansion to excellence will persist.

[1] Address on Commemoration Day at the Johns Hopkins University, February 22, 1937, celebrating the twenty-fifth anniversary of the founding of the School of Engineering at the Johns Hopkins University.

I would pay special tribute at this time to your two leaders, whom I am proud to claim as my friends. One of these, your dean, has served the School of Engineering from its beginning and has impressed on it his qualities of scholarship, of culture and that type of public service which he himself exemplifies in his important "extra-curricular" professional activities. The other is your "year-and-a-half"-old president, who is bringing to the service of this university those unusual qualities of clarity of judgment, creative imagination, decisive courage and statesmanship and warm loyalty to men and to objectives that are true and worthy, which I have so admired as I have come to know him in his leadership of organized science in the better performance of much-needed social service.

About a year ago I had occasion to discuss Science in connection with a symposium on "An American Program for Social Progress," arranged by the National Industrial Conference Board. On this occasion it seems appropriate to speak on the closely related subject of "Engineering in an American Program for Social Progress." For this twenty-fifth anniversary of the founding of the School of Engineering of this great university naturally turns our thoughts to an appraisal of the rôle of engineering in our society and to an attempt thereby to chart a wise course for the future, whereby engineers and engineering can best perform that service to the public which is the justification for their existence.

It is obviously not my function to chart the course for engineering at Johns Hopkins University. This is the responsibility of your trustees and administrative officers. But I can review some factors which are important in the consideration of engineering education, whether here or elsewhere, and which should be considered in the formulation of policies by any body which has to do with engineering. Government, university, business, labor, agriculture and the public generally all have a vital concern in these questions, as I shall show.

The outline of my discussion of these matters is exceedingly simple, for it is based on just two questions: "What elements are involved in the American program for social progress?" and "What is the proper rôle of engineering in each feature of this program?" But before dealing with these questions, it is well to consider briefly what engineering is and how it has developed.

On the walls of the national headquarters of the engineering societies in New York there hangs the definition: "Engineering is the art of directing men and controlling the forces and materials of nature for the benefit of the human race." This is so broad a definition that some may question its justification. But while there are many who do not call themselves engineers (as, for example, the President of the United States or the Secretary of Agriculture or the presid of a steel company or the head of a labor unio "who direct men and control (or try to control) t forces and materials of nature for the benefit of t human race," nevertheless such men are really ope ating to a great extent in the field of the engine And to the extent to which they follow the methods the engineer—in basing policies upon facts, in utilizi knowledge to achieve results, in depending on l rather than hunch, in giving attention to foundatio before erecting superstructures, in using imaginati disciplined by experience, in thinking through to t goal before starting on the way—to this extent w their efforts be "for the benefit of the human race."

That quality of the engineer of achieving results h been so notable as to have received recognition in t dictionary in the coinage of a new verb, "to engineer For it is common parlance to say "he engineered deal," or "we need some one to engineer this project Such phrases reflect the common realization of t public that the methods of the engineer are sound an successful. The fact that this realization is tacit an almost subconscious is all the more evidence that it derived from a long background of experience of m dertakings successfully carried through by engineer

It is this quality of performance in matters of pra tical importance that distinguishes the engineer fro his close relation, the scientist. The pure scientist co cerns himself with the study of the materials, force and phenomena of nature. The applied scienti bridges the gap between science and its use, and h function is to interpret and extend in order that utili may ensue. The engineer bridges the gap between sc ence and the public, and his function is to develop t applications of science in such manner that they ma fit beneficially into the existing organization o civilization.

It is significant that the engineer is a relatively ne actor on the stage of world progress: he is both th product and the cause of our technological age. would not imply that there were no engineers in pa ages; Archimedes, the Roman road and aqueduct build ers and Leonardo da Vinci were great engineers. Bu as a profession, engineering is of relatively recen origin. Great universities in Europe have existe since antiquity, with their professional schools of la medicine and theology. In America, Harvard cele brated last fall its three hundredth anniversary. Bu Rensselaer, the oldest engineering school in this cou try, was founded only 113 years ago, my own institu tion 72 years ago and your school only 25 years ago Although there are now 155 degree-granting engineer ing schools in the United States, enrolling about on tenth of the country's college student population, mos of these schools are relatively young and all started

small. Thus, compared with other great professions, the systematic training of engineers scarcely extends beyond the lifetimes of the older men now in the profession. This fact serves to enhance the significance of the importance and success which engineering has achieved.

During this less than a century of development, the character of engineering education has undergone important changes. In the early days the professional curriculum consisted of pure science, the applied science of the day and the techniques of practical work in shops or in the field. As great industries developed, based on technological advances, the curriculum took on more of systematic training in the processes and techniques of these industries, became more crowded with newer and newer specialties, with some tendency to crowd out the basic sciences and much pressure to stuff the student with all the factual knowledge and techniques which he might later be called upon to use. This trend finally broke for two reasons: it became impossibly unwieldy and it became out of tune with industrial demands in the following manner.

In their early development, industries had to depend largely on the engineering schools to provide both the knowledge and the technical, often manual, training which their operations required. But now the larger industries can, and prefer, to do much of the training of their new employees in the particular techniques and operations which they use. Their great demand is for young engineers who are so well grounded in the sciences and in the fundamental theories of engineering as to be capable of grappling effectively with the new problems and ever-advancing arts that are associated with technological progress.

So the recent tendency of the engineering schools has been to reduce emphasis on shop practices—leaving most of these to the technical or trade schools and to apprentice training courses in the industries themselves; also to postpone the more specialized training into postgraduate years; and to concentrate chiefly on basic science and fundamental engineering, together with more attention to the economics and social science which are becoming more and more the concern of the engineer. In this program, such specialization as remains in the undergraduate curriculum is more for the purpose of training the student how to specialize than for producing a specialist.

We thus have emerging, to meet present and future needs, this type of undergraduate engineering school. In favorable situations such schools are being extended to rapidly increasing attention to postgraduate training in specialties and in research, and coincidently, increasing activity in assisting industry to solve some of its more obscure or forward-looking problems.

But industry requires both engineers and technicians—about four technicians to every engineer, according to a recent survey by the Society for the Promotion of Engineering Education. The situation is too complex for one and the same school to try to train both engineers and technicians, and do a good job with either. So the latter function is being more and more taken over by the industries themselves and by the technical and trade schools, as distinguished from the engineering schools. Naturally, however, all gradations between these extremes exist among the numerous engineering and technical schools of the country.

In this classification, the School of Engineering of Johns Hopkins University lies definitely in the category of the progressive engineering school. Undoubtedly this is due both to its youth and to the high scientific ideals of its founders, its administration and its environment in the university.

And now, against this background of the nature of engineering and the training of engineers, let us cast a picture of some major features of the American program for social progress. America needs work for some millions of unemployed. She craves protection against the perils of nature, such as floods and earthquakes and droughts, and against the man-made perils of transportation, fire and group violence. Wisdom urges her to seek conservation of her natural resources of soil, minerals and power. She needs better housing for large groups of her population. She realizes the advantages which would derive from a more efficient system of distribution of her products to her consuming public. Her people are striving, sometimes with violence, for higher wages, shorter hours of labor and a generally higher standard of living.

These are the things which are the major goals of our federal administration and our local governments and which are at any rate the most vocalized aspirations of our people. And every one of these things not only involves engineering, but can only be achieved through engineering, by engineers! This is a striking fact, of large significance in determining what should be our attitude toward the engineer and his training.

To emphasize this point let me suggest that good laws, proper financial adjustments, brotherly love and justice can all facilitate the happy attainment of these goals which I have mentioned, and their opposites can wreck us, but without engineering they are practically without avail to achieve the goals. As to their achievement, one might almost paraphrase the Holy Writ and say that, without engineering, laws and financial schemes are as sounding brass or a tinkling cymbal. For all these goals require the creation of physical things for the accomplishment of definite purposes. Laws and finances may give the setting, but the actual creation is the job for the engineer.

If I am right in this analysis, which I will proceed

in a moment to defend, is there not lacking a sense of proportion and fundamental understanding in some of the efforts which are being so feverishly exerted by our national leaders in their campaign to raise standards of living through such devices as distribution of wealth, creation of artificial employment, regulation of wages and hours of labor or curtailment of production—while practically neglecting effective methods of stimulating science and engineering to lay a solid basis for future progress?

Now let us turn more specifically to those major features of the American program which I listed a moment ago. The first was:

Reduction of Unemployment

Far and away the greatest task which has faced the American people in the last four years has been to take care of the great group of unemployed which appeared with the depression in numbers two or three times as great as the normal unemployable population. There can be nothing but praise for the promptness and boldness with which this emergency was tackled by the Federal Administration, whatever may have been the faults typical and perhaps unavoidable in so great and so sudden an enterprise. With this program of providing emergency work and providing outright relief when necessary, we have come through to better times. The basic problem, however, is far from solved, for unemployment still stands at figures nearly double the estimated unemployable population. Perhaps our greatest national problem is still that of handling this unemployed population. We could cheerfully support almost any emergency measures if we could see that they were leading us toward a permanent solution. What is the permanent solution?

There have been several schools of thought in this question, falling between the extremes illustrated by two incidents. One portrays the share-the-work movement reduced to an absurd extreme. The other presents the extreme claim of those who foresee the solution in the creation of new industries, by engineering science.

In the early days of the depression in one of the western states, the legislature had voted an appropriation for road building to provide employment. During the discussion, one legislator moved an amendment to the effect that no labor-saving machinery of any sort should be used in the construction, so that the maximum number of people might be employed. One of his colleagues then jumped up to amend the amendment, to specify that the workmen should be equipped only with teaspoons, in order that the maximum number of them might be required to perform the job. Without any further argument, I think, we can assert that this idea of dividing the work, while it may be advantageously employed up to a certain point in some situations, does not hold the key to an ideal solution of the unemployment problem. It is essentially unconstructive and represents a move backward in man's development as a creative being.

The other extreme was typified in 1934 by a joint symposium of the American Institute of Physics and the New York Electrical Society on the subject, "Science Makes Jobs." Here the speakers, of whom I was one, drew a vivid picture of the tremendous employment which has been made available through the development of the telephone, the automobile, the electrical and the chemical industries, all products of science and invention within the last generation or two and now affording not only luxuries and new necessities of life but also affording a livelihood to a very substantial portion of our total population. One of the speakers quoted Dr. Kettering's remark that the "trouble with us was not the over-production of goods but the underproduction of new ideas." The audience was asked to consider how much earlier and more severely the unemployment problem would have struck the country if even one or two only of these great technological industries had not been developed some decades ago. From this the inference was drawn that the most positive direction in which to seek jobs for the future is through the science and invention which join in productive engineering.

Of course the argument is not quite as simple as this last statement would imply. For example, if the automobile industry, together with the subsidiary business like sales, service, and oil, did not now provide employment for some three millions of our population, it does not follow that these three million people would now be unemployed. Some of them would never have been born, because their parents would have been too poor to raise more children. Some of them would have died in childhood, because the community could not have afforded the present standards of sanitation and medical care. Certainly many of them would be unemployed, and all the rest would be competing for work in the remaining industries—holding down the wage scale and all struggling for meager existence. I think we can certainly say that had the automobile industry not developed there would have been much more unemployment than there is now; there would have been far more misery, and the general standard of living would have been lower. Thus the automobile industry and every new creative industry is a boon to labor, to the consumer, and in fact to all the public.

Out of all the thought and discussion which have centered around the problem of unemployment this year, it seems to me that two features typified by the two examples just mentioned stand out rather clearly. One is that we have a responsibility to share the work

which is available to as great an extent as this may be consistent with good production and general economy. I shall have more to say about this point when we come to the subject of higher wages and shorter hours. The other feature is that the positive constructive cure for unemployment is to provide more really useful employment, which means to provide more things which people want and are willing to pay and to work for. Again we see that the constructive solution of the unemployment problem falls within the scope of engineering work.

When we consider the relatively small attention which has been paid to this constructive side of the problem of unemployment in the midst of the recent tremendous efforts to provide temporary relief, and to "prime the pump," I think we have food for some very serious thought. It does no good to "prime the pump" unless the well has been driven down to the ground water level; otherwise no water is pumped except what was poured in for priming. Similarly, unless the basis of emergency work reaches down to the creation and production of new things which people will work and pay for to possess, the emergency work is of little more value than a "setting-up" exercise. It is not only true that our policies have not devoted much attention to this basic and forward-looking problem of stimulating new industries for the future, but it is unfortunately true that there has been much, either directly or secondarily, in policies which have recently been put into effect for other purposes, which acts as a definite deterrent or penalty to constructive steps toward new industries and employment by private agencies. In other words the government has been relatively inactive and at the same time has permitted tax and code legislation which definitely inhibit action by private agencies in the directions which would bring ultimate employment.

However these things may be, one thing, I believe, is clear, and this is the main feature of my argument. It is that the engineer has a key position in the solution of the unemployment problem.

Protection against Perils

The second major feature of our American program is protection against both natural and man-made perils. Scarcely a year passes without some major catastrophe which takes the lives of hundreds, causes suffering and hardship to thousands and destroys millions of dollars worth of property. Within the past month we have had the greatest flood in the history of the Ohio River. Last year came great floods in New England. Two and three years ago drought and the dust storms devastated the great plains of the West. Earthquakes have done great damage in California on a few occasions, and cause the inhabitants continual uneasiness.

When we come to protection against man-made hazards, we have continually brought to mind the safety of the highways and of airplanes through almost daily news of fresh disasters; and on the larger scale we have the problem of national defense.

The significant thing about every one of these items of protection of large groups of people against peril and hazard is that each one is primarily the job of the engineer. It was the army engineers who directed and carried out the safety measures in the recent flood of the Ohio and Mississippi Rivers and under whose jurisdiction rests control of the waters of all navigable streams. It was Arthur Morgan as an engineer who directed the fine project of flood control in the dangerous Miami River Valley in such fashion that this region has never again been in serious danger. It will be engineers who will do what can be done for protection against drought on the great plains through water storage projects and measures for impounding water in the soil. The problem of highway safety is primarily one for engineers, both in the design of highways and in the design for automobiles. Safety in the air, while still carrying a large element of the human equation, is nevertheless ultimately a problem for the engineer to design planes of such stability and to steer them to their destination with such certainty and to construct them with such durability that they are dependable as machines and make safety largely automatic in the hands of the pilot. In our national defense the construction and operation of ships is an engineering job of the highest caliber, and the predominating engineering work of the army is shown by the fact that the United States Military Academy was founded as an engineering school and so continues.

One aspect of the engineer's work in protecting the public from hazards is illustrated in such elements as fire and earthquakes, for not only have the engineers designed fireproof structures, fire-extinguishing devices, fire alarms and fire-fighting equipment and have designed earthquake-proof buildings, but they have been largely responsible for the organization of the extensive system of fire, earthquake and similar insurance. This is a doubly advantageous arrangement, for not only does their training enable them to properly estimate the risks, but their training and self-interest both cause them to take the lead in devising ways and means to reduce the risks. The prominence of engineers in this field is illustrated by the fact that nineteen out of the twenty-three presidents of the Associated Mutual Factory Fire Insurance Companies are graduates of one signal engineering school, and for all I know the other four may also be engineer-trained.

If we consider the less spectacular but no less real danger which lurks in an impure water supply or a mosquito-infested swamp or a polluted stream, again we find that it is the engineer who is protecting the public from danger.

(To be concluded)

OBITUARY

FREDERICK VERNON COVILLE

DR. FREDERICK V. COVILLE, principal botanist in the U. S. Department of Agriculture, honorary curator of the U. S. National Herbarium under the Smithsonian Institution, and acting director of the National Arboretum, died at his home in Washington, D. C., on January 9, of coronary thrombosis sustained a week earlier. He was born in Preston, N. Y., on March 23, 1867, and was married in 1890 to Miss Elizabeth Harwood Boynton, who with three sons and one daughter survives him. He is best known for his achievements in botanical and agricultural research, but his interests were many and his contributions in widely different fields, particularly that of public welfare, were noteworthy.

After graduation at Cornell University (A.B., 1887), Dr. Coville taught there a short time, served as botanical assistant on the Arkansas Geological Survey, and in July, 1888, was appointed assistant botanist in the Department of Agriculture. In 1893 he succeeded Dr. George Vasey as botanist and as curator of the National Herbarium, then in the custody of that department. Upon the reorganization of scientific work within the Department of Agriculture in 1901 he was placed in charge of botanical investigation and experiment in the newly created Bureau of Plant Industry and, under varying titles, continued in that capacity during the remainder of his life.

Dr. Coville's most important field work was that as botanist of the famous Death Valley Expedition in 1891, the results of which were published two years later as "Botany of the Death Valley Expedition." This volume, one of the earliest critical studies of desert vegetation, is classic. It is a characteristically thorough piece of work, composed in the simple lucid style that distinguished all his writing, and aside from its precise identification of species is notable for the introductory chapters on ecological plant geography, based on personal observation and study, which present a searching analysis of the climatic and edaphic features of the region in their relation to its vegetation. Dr. Coville's keen interest in desert plants never waned. Later, as adviser to the Carnegie Institution of Washington, he procured the foundation of the Desert Botanical Laboratory near Tucson, Ariz., and at the time of his death was engaged in writing a popular but detailed flora of Death Valley, which should take account of much new material, including specimens collected by himself on three recent trips (1931–32).

In purely taxonomic work Dr. Coville devoted himself especially to the rushes (Juncaceae), in which he was long the acknowledged American authority, and to our native currants and gooseberries (Grossulariaceae), of which, jointly with Dr. N. L. Britton, he published a systematic treatment in "North American Flora." Many papers in his list of nearly 175 titles include descriptions of new species in other families as well as discussions of nomenclature and matters of bibliography; others trace in detail the routes of early botanical exploration in the West; still others relate to ethnology and to the plants used by the American aborigines; and more than a few, based on personal studies in the western United States, deal with practical problems of grazing and forestry. Assisted by Mr. W. F. Wight and others he prepared the botanical definitions for the revised edition of the Century Dictionary. The final establishment of a National Arboretum was due largely to his perseverance and his unflagging devotion to the project. For many years also he served as chairman of the Research Committee of the National Geographic Society and thus was influential in determining its policy of exploration.

On the score of public service there may here be quoted an expression of opinion received from Gifford Pinchot, first forester of the United States:

> Until the Forest Service developed a body of experts of its own, Frederick V. Coville was the first and the earliest authority on the effect of grazing on the forest.
>
> In February, 1898, the old Division of Forestry published a bold and masterly discussion by Dr. Coville on forest growth and sheep-grazing in the Cascade Mountains of Oregon, which went straight to the root of a very bitter controversy. In this study Dr. Coville laid down the essentials of a sound and far-sighted grazing policy.
>
> When a vital issue arose, in 1902, between the irrigation farmers of the Salt River Valley in Arizona and the wool-growers who ran their sheep on the irrigators' watershed, Dr. Coville's unequalled experience of grazing and plant life was called in. He and I made an extensive study on the ground, accompanied by representatives of the contending sides, and settled that and other questions. Our report rested on Dr. Coville's profound field knowledge of his subject, indefatigable thoroughness, and conspicuous fairness and common sense. He was already my friend, but that trip laid more deeply the foundations of a friendship which lasted throughout his life.
>
> In 1905 the Public Lands Commission published Dr. Coville's proposals for the regulation of grazing on the public lands. Then and later his advice was in demand. His part in formulating a national grazing policy was that

the pioneer. If Dr. Coville's advice had been taken, e West would have escaped vast losses which have since llen upon it.

From 1910 onward, however, experiments in blue-rry culture took precedence of his other interests, d it was this investigation in cultivating, hybridizing d selecting improved strains of the blueberry plant at gave full play to Dr. Coville's special abilities—s keenness of observation and fine technique of work-anship, and an almost infinite patience in following t details. Many collateral problems had also to be lved—in particular, the effect of soil acidity upon lant growth and the stimulating rôle of cold—with e final result that large-fruited "domesticated" blue-rries, in many fine varieties, are now securely estab-shed as a profitable commercial crop in the acid sandy ils of our eastern coastal plain. Largely through his ork and writing the artificial acidulation of soils and e basic requirements in the culture of acid soil plants re matters of general knowledge at present.

Notwithstanding this record of accomplishment, Dr. oville's time seemed never his own. Of unusually road interests and possessed of sound judgment in ractical matters, he was constantly besought for ad-ice upon all sorts of questions and projects by many ho knew his never-failing spirit of helpfulness. His riendly cooperation was proverbial; equally his com-ent, based on quick perceptions and a wide experi-nce, was penetrating and apposite. As the necessary tarting-point and background for economic work with lants he always emphasized the importance of sound axonomic studies. Himself a clear thinker, he was mbued with almost a passion for accuracy and pre-ision. Thus his influence over a long period of years as uncommonly helpful and inspiring to younger men ithin the department and it was effective also in a far ider scientific and educational field, where it will be orely missed. He will long be missed also in other alks of life, for he had in high degree that quick un-ffected and sympathetic interest in people that is the enius for friendship.

Erect and well over six feet in height, Dr. Coville was f distinguished bearing; in college he had been an out-tanding athlete. He was conservative and of great atural dignity; but coupled with this there were boy-sh enthusiasms that had to be shared with his friends, nd those who had the privilege of out-of-door associa-ion with him will cherish their recollections of his com-radeship. A field trip, even a walk through familiar oods, took on new possibilities of enjoyment from his wareness of the surroundings and his keen interest in very living thing therein, and was bound to yield new nformation or help to satisfy some question to which his inquisitive spirit seemed always to lead. He had moreover a profound appreciation of beauty in nature —a depth of feeling that often enough is smothered by matter-of-fact scientific accomplishment. His mind was stored with a lifetime's recollections of field incidents, of plants in a particular setting, and of other natural phenomena, and on occasion these memories would be brought forth as vividly as if the happenings or scenes were of yesterday, and, one may add, with astonishing detail as to essentials. Out of an active mind so equipped, trained and stored, the new "Death Valley Flora" would have been a fitting sequel to his earliest and most important botanical work. That he could not complete this upon retirement from government service, which would have followed shortly, will be a matter of general regret. But to those who knew Dr. Coville well a sense of personal loss will prevail, in the passing of a friend in whom steadfast loyalty and consideration were never wanting.

WILLIAM R. MAXON

SMITHSONIAN INSTITUTION

RECENT DEATHS AND MEMORIALS

DR. ELIHU THOMSON, of the Thomson-Houston and General Electric Companies, director of the Thomson Research Laboratory at Lynn, Mass., died on March 13 at the age of eighty-three years.

DR. WILLIAM HARDING LONGLEY, professor of biology at Goucher College since 1919, in administrative charge of the Marine Laboratory in Tortugas of the Carnegie Institution of Washington, died on March 10 at the age of fifty-six years.

DR. RANDOLPH WINSLOW, emeritus professor of surgery at the school of medicine of the University of Maryland, died on February 27 at the age of eighty-four years.

DR. ARTHUR RUDOLPH MANDEL, professor of clinical pathology at New York University Medical School, died suddenly on March 7. He was fifty-nine years old.

DR. ALFRED DOUGLAS FLINN, since 1922 director of the Engineering Foundation, formerly deputy chief engineer of the Board of Water Supply of the City of New York, died on March 14 at the age of sixty-seven years.

WILLIAM TAYLOR, inventor and maker of improvements in scientific apparatus, especially lenses, governing director of Taylor, Taylor and Hobson's, Leicester, England, died on February 28 in his seventy-second year. He was elected a fellow of the Royal Society in 1934, and was a member of the Council of the National Physical Laboratory and past president of the Institution of Mechanical Engineers.

Nature states that to commemorate the services of

the late Sir Grafton Elliot Smith to University College, London, and to the advancement of anatomical and anthropological teaching and research, it is proposed that a bust of him should be modeled in bronze by A. H. Gerrard, of the Slade School, and placed in the Thane Library of the college. Contributions towards the cost of the bust, made payable to "The Elliot Smith Memorial Fund," should be sent to Professor J. P. Hill, University College, Gower Street, London, W.C.1.

SCIENTIFIC EVENTS

JOINT MEETING ON AGRICULTURAL PROCESSING

THE American Society of Agricultural Engineers and the Process Industries Division of the American Society of Mechanical Engineers and Farm Chemurgic Council held a one-day meeting on agricultural processing, at Rutgers University, on February 26.

This meeting was planned to bring together the chemists and physicists who originate processes of making new useful products from various farm-grown materials; the processing engineers who develop and apply the processes on a commercial scale, and the agricultural engineers who are interested in enabling farmers to deliver the basic materials to processing plants within the required limits as to cost, physical condition and time and quantity of delivery.

L. F. Livingston, past-president of the American Society of Agricultural Engineers and manager of the agricultural extension section of the E. I. du Pont de Nemours and Company presided at the morning session which opened at 10 o'clock. Papers read at this session included "Processing Research in Agriculture," by John F. Ferris, acting director of the agricultural industries division of TVA; and "Hemp and Flax from the Seed to the Loom," by George A. Lowry, of Lowry and Grant.

A "research luncheon" was held at the Elks Building at 1:00 P. M. Dr. W. H. Martin, director of research at Rutgers University, addressed the group on "Agricultural Research Work," and Dr. Paul L. Hoover, director of the New Jersey Engineering Experiment Station, spoke on "Engineering Research."

Victor Wichum, chairman of the Process Industries Division of the American Society of Mechanical Engineers, presided at the afternoon session. In the afternoon Mr. Livingston gave an address on "Processing Engineering in Agriculture." He was followed by C. E. Thomas and A. Weisselberg, of the drying committee of the Process Industries Division, with a paper on "Drying of Agricultural Products—The Technical and Economical Aspects."

R. C. H. Heck, of the department of mechanical engineering, and E. R. Gross, head of the department of agricultural engineering, Rutgers University, were in charge of local arrangements for the meeting.

COSMIC RAY RECORDING STATION IN MEXICO

DR. ARTHUR H. COMPTON, of the University of Chicago, accompanied by Professor M. S. Vallarta, of the Massachusetts Institute of Technology, established during his recent visit to Mexico a permanent cosmic ray recording station, the fifth of the series that he is using for the measurement of the rays. Dr. Joaquin Gallo, director of the Mexican National Magnetic Observatory, and Dr. Mongez Lopez, director of the study of physical sciences of the National University of Mexico, of which the observatory is a part, are cooperating in the work.

The cosmic ray observatory is a small frame building erected on the grounds of the National Magnetic Observatory at Teolyucan, thirty miles north of Mexico City at an altitude of about 7,500 feet in a region far from any high mountains or buildings. The building is constructed with good thermal insulation so that both the diurnal and annual temperature variations are very small, amounting to a maximum of about 5° C.

The cosmic ray meter is one of the "Model C" meters of the type prepared for the Carnegie Institution of Washington. Its ionization chamber consists of a 20-liter steel sphere filled with argon at 40 atmospheres. The ionization by the cosmic rays is normally balanced by that due to the beta rays from a uranium rod, which enter an auxiliary chamber. This balance is unaffected by changes in temperature or pressure of the gas. The sensitivity is so adjusted that the maximum changes in the cosmic rays give variations in the reading of the meter which remain on the scale of the instrument. The records are made continuously on photographic paper and are being analyzed at Chicago.

A feature in connection with the operation of an observatory at this site is that because of the high altitude the cosmic ray bursts are more frequent than at sea level. For this reason the variations in the cosmic rays are greater and the sensitivity at which the meter operates must be lowered in order that the deflections of the meter shall remain on the scale. The immediate program is one of study of the diurnal and seasonal variations over a period of eighteen months. It is hoped, however, to continue the records for a longer time.

Permanent cosmic ray meters have been installed in Chicago, Washington, D. C., at Huancayo, Panama, and at Christ Church, New Zealand. Another meter has been installed on the *S. S. Orangi,* a steamship which plys the route from Vancouver to Australia. On each voyage, the meter readings give the difference in incidence of rays between the northern and southern hemispheres. The Chicago station is to be placed on Mt. Evans, Colorado, and another, temporarily located at the Massachusetts Institute of Technology, will be shifted to Greenland. There are only two other stations, those of Hess and Schonland, both of these having been made by E. Steinke, the German physicist.

SCIENTIFIC MEETINGS AT LANCASTER, PENNSYLVANIA

THE Pennsylvania Academy of Science, the Junior Academy, the Pennsylvania Conference of Teachers of College Physics and the Lancaster Branch of the American Association for the Advancement of Science will hold a joint session at the time of the annual meeting of the academy at Lancaster on March 26 and 27. The Lancaster Branch and Franklin and Marshall College are to be hosts. All scientific activities will be held on the college campus. Friday morning and afternoon, March 26, will be devoted to general sessions divided into subject groups, physics, biology, miscellaneous papers and the Junior Academy. Exhibits will supplement the sessions. The annual dinner has been scheduled for Friday evening at the Hotel Brunswick. This is to be followed by an address by Dr. F. R. Moulton, distinguished for his work in mathematics and astronomy, permanent secretary-elect of the American Association for the Advancement of Science. Dr. Moulton will speak on "Science."

Saturday's session is to commence with a brief business meeting at nine in the morning, followed by short invited papers as follows: "The Birds of Lake Ontelaunee, Berks County," Earl L. Poole, Reading Public Museum; "The Status of the Upland Plover in Pennsylvania," Professor Herbert H. Beck, Franklin and Marshall College; "Reminiscences of Professor William S. Franklin," Professor R. L. Charles, Franklin and Marshall College; "Effects of Pressure and Temperature on the Germination of Seeds," Dr. R. B. Dow and Dr. Rafael Rivera, Pennsylvania State College; "Measuring Gravity at Sea," Professor Maurice Ewing, Lehigh University; "The Origin and Occurrence of Earthquakes," Professor H. Landsberg, Pennsylvania State College; "Some Biological Effects of Sounds of High Intensity," Dr. L. A. Chambers, Johnson Foundation for Medical Physics, University of Pennsylvania.

The sessions will conclude at noon on Saturday. Buffet lunches are to be served at the college. Those planning to stay over night are requested to make their own hotel reservations. Inquiries may be addressed to Professor Wheeler P. Davey, State College, Pa., representing the Conference of Teachers of College Physics; Dr. V. Earl Light, Lebanon Valley College, Annville, Pa., secretary of the Pennsylvania Academy of Science; Dr. Karl F. Oerlein, State Teachers College, Indiana, Pa., representing the Pennsylvania Junior Academy of Science, or Jaques Cattell, Science Press, Lancaster, Pa., representing the Lancaster Branch, American Association for the Advancement of Science.

THE NORTH CAROLINA MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE ninety-third meeting of the American Chemical Society will open for a four-day session at the University of North Carolina on April 12. Fifteen divisions of the society will conduct symposia in various fields of research and a group of foreign scientific men will report on their work.

On Monday, April 12, the meeting will be opened by Dr. E. R. Weidlein, director of the Mellon Institute of Industrial Research in Pittsburgh, president of the society. Among those who will give addresses on the first day of the meeting will be Dr. Robert R. Williams, chief chemist of the Bell Telephone Company Laboratories in New York and a research associate at Columbia University, whose discovery of the chemical structure of vitamin B led to synthesis of the vitamin.

Dr. Williams's work and subsequent experiments made possible by them will play an important part in a symposium on Vitamin B, which will be held on the second day of the meeting, in which the Divisions of Agricultural and Food Chemistry, Biological Chemistry and Medicinal Chemistry will cooperate. On the following day these same divisions will work together in a symposium on other vitamins.

Cellulose chemistry, synthetic plastics and the chemistry of solid surfaces will be discussed in other symposia to be given in division meetings. The Cellulose Division will devote Tuesday to a general symposium on cellulose developments, and on Wednesday will hold two sessions for the presentation of general papers. On Wednesday morning the Division of Paint and Varnish Chemistry, under the chairmanship of Dr. Gordon M. Kline, will hold a plastics symposium, and the Division of Physical and Inorganic Chemistry will report work in the chemistry of solid surfaces.

Studies of sugars, starches and related products, including a report on the bacteriological analysis of more than 1,000 different sugars, will be taken up at the meetings of the sugar division. The division of microchemistry will present papers on the stability of cellulose nitrates and other explosives, and reports on the latest advances in the design of laboratories and equipment.

Papers on high-speed vulcanizing to step up the production rate of rubber-insulated wire, tests of the efficiency of various types of rubber as vibration absorbers and a new type of hammer test for the elasticity of soft rubbers will be presented to the Rubber Division. The behavior of emulsions and the surface tensions of various liquids and their effect on each other will be among the subjects taken up at the meetings of the colloid division.

Other fields to be covered in divisional sessions through symposia and general papers are chemical education, gas and fuel developments, industrial and engineering progress, organic chemistry and water, sewage and sanitation chemistry.

Dr. Frank K. Cameron, professor of chemistry at the University of North Carolina, has been designated honorary chairman of a local committee to make arrangements for the convention. The general chairman is R. M. Grumman, of the university, and E. C. Markham will act as secretary-treasurer. Other committee members are: Housing, J. S. Bennett; meeting rooms, H. D. Crockford; registration and information, G. M. Hill; group dinners and luncheons, Haywood Duke; transportation, Herman Schnell; entertainment, Harry Comer; plant visits and sightseeing trips, J. Maryon Saunders; publicity, R. W. Madry; golf and tennis, R. B. Lawson; safety, P. L. Burch; women's activities, Mrs. Edward Mack, Jr.; women chemists, Miss Frances Brown.

THE JOHN SCOTT AWARDS

As has been already recorded in SCIENCE, Dr. W. D. Coolidge and Dr. Irving Langmuir, director and associate director, respectively, of the Research Laboratory of the General Electric Company in Schenectady, and Dr. Evarts A. Graham, of the School of Medicine of Washington University in St. Louis, were recipients of the John Scott 1937 awards granted by the City Trusts of the City of Philadelphia at a dinner of the American Philosophical Society on March 5. With each award went a certificate, a copper medal and $1,000 in cash.

The award to Dr. Coolidge was based on his application of a new principle in x-ray tubes; to Dr. Langmuir for his physical and chemical discoveries resulting in improved gas-filled incandescent lamps, and to Dr. Graham for his application of the x-ray to the study and diagnosis of gall bladder conditions.

In making the presentations, Ernest T. Trigg, chairman of the Board of City Trusts, explained that history had made but scant recordings of John Scott, the donor of the fund, and his reason for bequeathing to the City of Philadelphia in 1816 the sum of $4,000, the income from which was to be "laid ont in premiums to be distributed among ingenious men and women who make useful inventions." It was originally stipulated that no award was to carry a cash premium of more than $20 and the medal was to be inscribed "To the most deserving."

John Scott was a chemist in Edinburgh, Scotland, and why he chose Philadelphia for his grant is a mystery. It is thought his attention had been drawn to the city either through the American Philosophical Society or his admiration of Benjamin Franklin, whom he may have met when Franklin visited Scotland in 1769. When the fund was taken over by the newly created Board of City Trusts, the principal had grown to $21,000, and in 1917, or 100 years after the original grant, it amounted to $100,000. At this time the board appealed to the courts and received permission to increase the amount of the awards to a maximum value of $2,000, but none has been for any amount greater than $1,000.

In the period between 1920 and 1937, inclusive, 73 awards have been made to scientific men and inventors in all parts of the world, including Japan, Holland, England, France, Italy and South America. Among the recipients have been Madame Curie, Reginald A. Fessenden, Orville Wright, Lee de Forest, Thomas A. Edison, Guglielmo Marconi, Samuel M. Vauclain, W. L. R. Emmet, Nikola Tesla, Charles F. Kettering and Edward G. Budd.

SCIENTIFIC NOTES AND NEWS

DR. SIMON FLEXNER, director emeritus of the Rockefeller Institute for Medical Research, New York, was elected a foreign associate of the Academy of Sciences, Institute of France, at a meeting held in Paris on February 22. He succeeds the late Emanuele Paterno, Marquis di Sessa, of Palermo, Sicily.

DR. CARL G. HARTMAN, of the department of embryology of the Carnegie Institution of Washington, has been elected to membership in the International Institute of Embryology at Utrecht.

DR. REUBEN L. KAHN, since 1928 director of laboratories, University Hospital, and assistant professor of bacteriology at the University of Michigan Medical School, was recently presented with a gold medal by the Phi Lambda Kappa fraternity for his research work in tissue immunity. The presentation took place at the annual meeting of the fraternity in Detroit.

THE 1936 Manly Memorial Medal recently awarded to Raymond W. Young, assistant engineer of the Wright Aeronautical Corporation, Paterson, N. J.,

for giving the best paper of the year on aeronautical science before the Society of Automotive Engineers, was presented to him on March 12 at a dinner at the Hotel Mayflower in Washington, D. C.

THE foreign secretary of the Physical Society, London, in notifying Dr. Walter G. Cady, Foss professor of physics at Wesleyan University, of the award to him of the Duddell Medal for 1936, wrote: "Your pioneer work has stimulated research work on the subject in all parts of the world and has found practical applications in the quartz clock, the measurement and control of the frequency of alternating currents, and the measurements of the velocity of ultrasonic waves."

THE Cameron Prize for 1937 has been awarded by the senatus of the University of Edinburgh to Dr. J. Bertram Collip, professor of biochemistry at McGill University, in recognition of his contributions to endocrine therapy and in particular of his work on the parathyroid gland.

AT the recent meeting of the New Orleans Academy of Science at Hammond, La., Dr. H. L. Kearney, of New Orleans, was elected president. Chairmen of the sections elected were: Dr. John R. Fowler, Louisiana Polytechnic Institute, biological science; Dr. R. L. Menville, Louisiana State University, applied science, and D. T. Tarlton, Louisiana Normal School, social sciences. E. A. Fieger, Louisana State University, was elected permanent secretary, and Dr. Irby C. Nichols, Louisiana State University, editor. The academy awarded a gold medal for the best paper to Dr. Charlotte H. Boatner, of H. Sophie Newcomb Memorial College, and the original research prize of $25 to I. M. Le Baron, graduate student of Louisiana State University.

AT the annual meeting of the Royal Astronomical Society the following officers were elected: *President,* Dr. H. Spencer Jones; *Vice-presidents,* Sir Frank Dyson, Professor E. A. Milne, Professor H. C. Plummer and Professor W. M. Smart; *Treasurer,* J. H. Reynolds; *Secretaries,* W. M. H. Greaves and Professor H. H. Plaskett; *Foreign Secretary,* Sir Arthur Eddington.

DR. WILLIAM HENRY WESTON, JR., chairman of the department of botany at Harvard University, has been appointed visiting professor of mycology at the Johns Hopkins University.

DR. S. J. SHAND, of the University of Stellenbosch, South Africa, has been appointed professor of geology at Columbia University. He will conduct the courses in petrology. He is expected to take up the work in New York in September.

DR. OSCAR W. RICHARDS has resigned from the department of zoology at Yale University to accept the post of research biologist with the Spencer Lens Company. Dr. Trenton K. Ruebush, of the University of Virginia, has been appointed to succeed him. Dr. Donald F. Poulson, of the Carnegie Laboratory of Embryology, has been appointed to an instructorship in the department of zoology at Yale University.

AN exchange arrangement has been made by which Dr. Daniel Buchanan, dean of the Faculty of Arts and Sciences at the University of British Columbia, will conduct courses in astronomy during the summer session at the University of California at Los Angeles and Dr. Frederick C. Leonard, chairman of the department of astronomy at Los Angeles, will lecture at the University of British Columbia.

PROFESSOR JOHN MCLEAN THOMPSON, director of the Hartley Botanical Laboratory and dean of the Graduate School of the University of Liverpool, will be in residence from June 15 to July 22 in the Summer School of Botany at the Iowa State College at Ames. He will give courses on the morphology of the reproductive organs and on the evolution of plants.

DR. H. P. NEWSHOLME, medical officer of health to the City of Birmingham, England, has been appointed professor of hygiene and public health at the University of Birmingham to succeed the late Sir John Robertson.

DR. CHARLES ROBBINS SCHROEDER, veterinarian and pathologist of the zoological park at San Diego, Calif., since 1932, has been appointed veterinarian of the New York Zoological Park, the Bronx, to succeed Dr. Charles V. Noback, who died on January 16.

F. A. LOPEZ DOMINGUEZ, director of the Puerto Rico Agricultural Experiment Station, has been given leave of absence for a year to aid in the work of the Puerto Rico Rehabilitation Administration. Dr. Melville T. Cook has been appointed acting director of the station during his absence.

DR. SAÏM SAĞLIK, of the Gulhane Post-Graduate Medical School of Istanbul, and Dr. Elemér Scipiades, of Pécs and Budapest, are working on problems relating to reproduction at the department of embryology of the Carnegie Institution of Washington.

SIR ALDO CASTELLANI, surgeon-in-chief for the Italian army in Ethiopia, returned to New Orleans on March 5 to give a course of lectures in connection with his work as professor of tropical medicine at the Medical Center of the Louisiana State University.

DR. THOMAS J. HILL, professor of clinical oral pathology and therapeutics of the School of Dentistry of Western Reserve University, and Dr. Morris Steggerda, of the Carnegie Institution, Washington, D. C.,

have left for Chichen Itza, Yucatan, to make a study of dental caries among the Mayan Indians.

DR. COLIN G. FINK, professor of electrochemistry at Columbia University, addressed the members of the Royal Canadian Institute at Toronto on February 27 on "Products of Electrochemistry," referring in particular to his own researches.

THE seventh Joseph Henry lecture was delivered by Dr. James Franck, professor of physics at the Johns Hopkins University, before the Philosophical Society of Washington on March 13. He spoke on the "Fundamentals of Photosynthesis."

DR. ARTHUR HAAS, formerly of the University of Vienna and at present of the University of Notre Dame, addressed an open meeting of the Purdue University Chapter of Sigma Pi Sigma, physics honor society, on February 25. He spoke on "The Fundamental Principles Underlying Modern Physics."

DR. ROBERT B. SOSMAN, of the Research Laboratory of the United States Steel Corporation, will give the annual Edward Orton, Jr., memorial lecture sponsored by the fellows of the American Ceramic Society, at the annual meeting in New York on March 23. The subject will be "Pyrometry and the Steel-maker's Refractories."

DR. LUDVIG HEKTOEN will deliver the first Christian Fenger Lecture of the Institute of Medicine of Chicago and of the Chicago Pathological Society at a joint meeting with the Society of Medical History of Chicago and the Chicago Surgical Society on the evening of March 26. His subject will be "Early Pathology in Chicago and Christian Fenger."

THE annual lecture of the James A. Gibson Anatomical Society at the University of Buffalo School of Medicine will be given on Tuesday evening, March 23, by Dr. S. W. Ranson, of Northwestern University. Dr. Ranson will speak on "The Hypothalamus." The Gibson Anatomical Society is an organization of students in the School of Medicine who have done superior work in the courses in anatomy.

A ROUND table discussion of "Capillaries" will be held at the meeting of the American Association of Anatomists in Toronto from March 25 to 27. Drs. Richard G. Abell, Robert Chambers, Eliot R. Clark, Eleanor L. Clark, James B. Rogers and B. W. Zweifach will contribute papers. The discussion will probably be led by Dr. R. R. Bensley and Dr. W. B. Cannon. Dr. E. V. Cowdry will preside.

DR. J. HOWARD MATHEWS, chairman of the department of chemistry at the University of Wisconsin, is making a lecture tour through the South and Southeast. The trip is sponsored by the American Chemical Society. The lectures which are given under the auspices of local sections of the society are entitled "Use of Scientific Methods in the Identification of the Criminal." They are illustrated by lantern slides and examples of the applications of the various techniques taken largely from the personal experience of the lecturer.

THE twenty-seventh series of the Hepsa Ely Silliman lectures will be delivered in April at Yale University by Dr. David M. S. Watson, Jodrell professor of zoology and comparative anatomy at University College, London. The subject of the lectures will be "Paleontology and Modern Biology," and they will deal principally with the character of the evolutionary process as illustrated by the study of the fossil vertebrates. The lectures will be eight in number and will be given in Strathcona Hall at 4:15 P.M., on alternate days of the week, beginning on April 12 and ending on April 28.

THE annual joint meeting of the Institute of Radio Engineers and the American Section of the International Scientific Radio Union will be held in Washington, D. C., on April 30. Papers on the more fundamental and scientific aspects of radio will be presented. There will be two sessions at the building of the National Academy of Sciences, 2101 Constitution Avenue, Washington, D. C., beginning at 10 A. M. and 2 P. M. Papers will be limited to fifteen minutes each to allow time for discussion.

THE ninth anthropological and archeological Smithsonian expedition to Alaska, under the leadership of Dr. Aleš Hrdlička, will leave Seattle on May 20. The object of this year's expedition will be as far as possible a thorough reconnaissance of pre-Russian village sites and burial caves on the Gulf coasts, on the Peninsula and especially in the Aleutian chain, with possibly a visit to the Commander Islands. As in the past, Dr. Hrdlička will take along a small number of volunteer students, who with him will carry on the work. In return they get such field instructions as may be possible and a course of lectures on the principles of anthropology and American archeology. The number of those that can be taken along must this year be limited to five because of difficulties of transportation. The applicants must be strong, healthy young men and earnest students. They pay their personal expenses, but these will be very moderate. Otherwise there are no charges. Recommendations by two professors will be required of each applicant. For further information write to Dr. A. Hrdlička, U. S. National Museum, Washington, D. C.

THE hundred and fifth annual meeting of the British Medical Association will open in Belfast on July 16

under the presidency of Professor R. J. Johnstone, professor of gynecology in Queen's University.

THE Oberly Memorial Prize will be awarded this year in the sum of $100 for the best bibliography submitted in the field of agriculture and related sciences. Four copies of each bibliography entered should, before March 31, be in the hands of the chairman of the Oberly Memorial Fund Committee, Gilbert H. Doane, director of University Libraries at the University of Wisconsin.

Industrial and Engineering Chemistry reports that the president of the American Welding Society has announced acceptance by the Board of Directors of a gold medal to be known as the Lincoln Gold Medal and to be presented to the author of the best paper on any phase of welding published in the *Journal of the American Welding Society* during the year October, 1936, to October, 1937. The donor of the medal is J. F. Lincoln, president of the Lincoln Electric Company, who makes this contribution as a stimulus to the preparation of worth-while contributions on the art of welding. Further information can be obtained from the society at 33 West 39th Street, New York N. Y.

THE Secretary of State for Scotland announces that the office of regius professor of chemistry in the University of Glasgow will become vacant on October 1, 1937, owing to the resignation of Professor G. G. Henderson, and that it is proposed to take steps with a view to the filling of the vacancy. Applications, accompanied by two copies of recent testimonials, should be addressed to the Private Secretary, Scottish Office, Whitehall, London, S.W.1, and should reach him not later than April 30.

PLANS are being prepared for an entire new group of buildings for the College of Engineering at Cornell University. The trustees have appropriated $5,000 for this purpose and have designated R. Harold Shreve, '02, of Shreve, Lamb, and Harmon, New York City, as architect. A detailed study of the present status and future needs of the college has been under way for some time and will be continued.

Industrial and Engineering Chemistry reports that the Bausch and Lomb Optical Company has opened a new laboratory for applied research in order to enter upon a broad program of fundamental investigations on the chemistry and physics of glass surfaces and on the development of new materials and processes for the industry. Frank P. Kolb is chief chemist, and Theodore J. Zak, assistant chemist. A series of laboratory units are devoted to research in the fields of metallurgy, experimental electroplating, spectroscopy, photomicrography and physical testing. One of the most interesting units is that in which James E. Wilson and his assistant, Vernon Patterson, are engaged in applying metallurgical equipment to the study of the structure of the steels and alloys used in industry. The testing and control laboratory, directed by Ray A. Kirchmaier and Joseph T. Anderson, is equipped for general analytical work. D. M. Webb has been added to the staff for research in chemistry, one of his immediate problems being the electrodeposition of various metallic substances as a backing for reflectors.

DISCUSSION

FOSSIL CYCAD NATIONAL MONUMENT

WHAT this monument (as set aside by act of Congress in 1922) means in the series of national monuments and to botanical science needs to be simply told, though clearly the remarkable flowering cycadeoids which give the monument its feature can never be fully told about in words alone. They need *in situ* exhibition. That's the reason for the monument. Thus far the great collections from the monument have received much attention in many and sumptuously illustrated scientific contributions. The more primary scientific values involved have had wide notice the world over in both paleontologic and botanic texts. Yet that splendid landscape so replete with geographic and evolutionary values has had but meager illustration. Moreover, exactly within the past ten years six distinct lines of study and research have greatly enhanced the monument values.

Firstly, the cycadeoids of the Beskids of the Carpathians have been given that exacter illustration which shows them to be related to some of the Black Hills types, close as are perhaps European to American oaks, the same being true of the cycadeoids of the Apennines, the Isle of Wight and the Isle of Portland. That is, we have here to deal with types of uncommon beauty and very wide distribution in both latitude and time. If the display at the monument is brought into and rigidly kept in a real unity it will always have a deep interest to the foreign visitor.

Secondly, there is now in view a fine addition of types from the Trinity Beds of Texas, as noted in SCIENCE. These are conveniently grouped as five new species, but so closely resemble the several Black Hills types as to suggest a mere southern outlier of the monument forest.

Thirdly, while the geologic age of the monument

types is Lakotan or very low Cretaceous, if not Jurassic, high up in the Upper Cretaceous or Mesaverde of New Mexico and Arizona there are now found to occur in a striking alignment three species of those free-flowering relatives with fruiting in all the frond base axillae. Such types have been for some time known to be of wide distribution ranging back to the close of the Jura, though hitherto exceedingly rare in collections. While closely related to Cycadeoidea, the free-flowering species (eight in all) are now set in a new genus *Monanthesia,* as named from the strong tendency to monocarpy or a single season flowering or anthesis. The Mesaverde species are *Monanthesia magnifica, M. blanca* and *M. equalis,* as already illustrated. That this general type extends back into the Jura and may be old is highly significant. The finest representative thus far discovered is the *Monanthesia* (Cycadeoidea) *Dartoni* from the Como or closing Jura of the Black Hills, taken as an equivalent of the Wealden of the Isle of Wight. This is not only one of the most remarkable of all ancient completely petrified plants, but one of the most elaborately studied and illustrated.

Fourthly, renewed attention to the petrified stems from the Isle of Portland shows them to be far more instructive than appeared during all early cutting as done without the aid of etching over larger surfaces. Of singular interest is what may be seen in the complete tangent armor sections of the *Cycadeoidea microphylla* of Buckland. From these sections it is found that what looks like a heavy globular to flat stem is merely a lesser, even slender stem bearing a mass of large bract-enveloped branches. The initial foliage fronds are few and small or little above scale leaves, while the bracts of the floral axes may bear small pinules proving the complete transition. The peduncular axes are really sizable branches. They emerge freely below the crown and reach large size. The main stem, though at first taken as simply columnar, may just as well be called ex-current with profuse branching. Measurements are here most instructive. A stem 25 cm in height with a woody cylinder only 8 cm in diameter and a thin cortical region bears an "armor" mass of small frond bases and many large bract invested peduncles or branches 15 cm in depth. The reproductive branches make up by far the greater bulk.

Fifthly, on the Fossil Cycad National Monument Mesa for the first time a serious quarrying operation was carried out with the aid of CCC help in November, 1935, bringing to light one ton of *in situ* specimens. Uneroded, unbroken, of varied specific type, nothing approaching such a collection has ever been seen before in the course of the even hundred years during which the cycadeoids have been better known as fossils. Rightly displayed in the field museum planned for the monument, this material alone will afford a singularly fine exhibit. There is a wealth of lesser leafed, branched and more generalized columnar types so highly instructive in tracing relationships and in proving how these plants, as fantastic as the cushion vegetation of the tropics or high mountains, may yet be traced through to their small-stemmed relatives of the Trias with a branching habitus like that of the magnolia.

Two types the botanist may do well to think of here are the branched *Williamsonia Dyeri* of the Trinity beds of Texas and a related long-known Jurassic species of the Paris Museum called *Clathropodium sarlatense.* The latter might be called *Cycadeoidea,* but is in no small degree an intermediate between that genus and *Williamsonia.* The heavy woody cylinder and relatively small medulla come near to more average gymnospermous woody stems. Small-leafed monument species like the *Cycadeoidea protea, C. minima* and *C. nana* also finely illustrate the transition.

Sixthly. The investigation of the marvelous petrified *Araucarian* forest of the Cerro Cuadrado, of north Central Patagonia, together with most important European studies, has led to a much broadened view of the floral morphology in the gymnosperms. Now at last it is seen how the cycadeoids, as seed fern derivatives, are far more nearly related to both the Cordaites and the conifers than was earlier even conceivable. In fact, the cycadeoids in their structural elements, both vegetative and floral, may be taken as left-overs from very ancient, even pre-Cordaites times. They show that the greater lines of seed plants were very much related to each other in their beginnings and that botanists must yet face the severe alternative of an all seed fern *vs.* all Lepidophyte origin for all the post-Paleozoic forest canopies. It's one or the other, with only a very minor chance that both great lines have shared in the long upward course. The more reasonable view is that the horsetails and club mosses of to-day are all that is left of the vegetation that in *Lepidostrobus* of Paleozoic times nearly reached the seed stage.

Here too must be mentioned the very instructive demonstration of the embryos of the Cerro Cuadrado Araucarians as brought out in the December, 1936, *Botanical Gazette* by Bertha Schweitzer Darrow. Mrs. Darrow shows that the two-cotyledon embryos of these older forms are typically Araucarian in feature. Thus is emphasized again the fact that the generalized embryo of the Araucarian is little different from that of the far older cycadeoids, however primitive polycotyledony and polyembryony may be. We are set visibly nearer some understanding of primitive embryonic factors and structures.

From the foregoing brief review it is seen that the cycadeoids of the Fossil Cycad National Monument are fundamentally important in botanical science. Furthermore, nowhere else so far have the specialized and heavy-stemmed branched types been found. Nor has a display of such gemstone beauty ever been brought together anywhere else on the globe.

Regarding the field conditions at the monument it merely remains to add that the location is a most sightly one and very accessible. At a moderate expense it can because of accessibility and surroundings be brought into a remarkable beauty of landscape, where the students may study at first hand in nature's own primitive setting the facts of the past, "the evidence that has never been tampered with by the hand of man," as Andrew Carnegie said. Furthermore, in addition to the plethora of material already had there is the sure promise of far more beneath the front mesa. The horizon is perfectly defined and traced around the monument borders. There are small shifts, slips or faults cutting these rim strata at various angles. But such have also tended to protect considerable material from loss by erosion. The cycadeoid level extends under fully three fourths of the entire monument area, while the trend of occurrence for the finest of the petrified stems indicates the presence within easy reach on the main mesa-capping of new material in excess of all ever recovered so far. One of the most splendid of all specimens, one of the most remarkable for beauty of silicification is the type *Cycadeoidea superba* which I secured absolutely *in situ* on the mesa cap at a point free from fault or shift for a long distance. Only shallow quarrying must reveal more such great specimens.

Fossil Cycad Monument more than all others of its series is as we now see dependent on an absolutely *in situ* development and display. Without this it can mean but little, as a mere blurred shadow, all but lost again in the shuffle of time. With it come into view a panoramic beauty, educational values of the highest and all that fuller realization of those far-away landscapes of dinosaur times, without some understanding of which we may scarce expect to learn or know life and ourselves.

What may the future wish and what do we owe? Shall we ourselves never develop the greater schools combining both exactitude and the open spaces? A recent summary shows that at the largest woman's college in the North (Hunter College of the City of New York) fully half the students preferred courses in some form of art. Here is time and here is nature in their highest expression. It is the artistic, trained sense that must best comprehend.

Just now, too, six students of the Yale Art School have in competition presented fully drawn-out plans for the monument field museum. All are of interest and merit. All show once and for all that the place for the monument display is on the monument itself and that there alone may a primary display be set to full advantage, there being as little reason for failure or going elsewhere as there would be for monumenting Gettysburg on other hills than where the historic action was fought.

The proposed Fossil Cycad National Monument development, as now quite definitely planned, will cost $65,000 initially. The question as to whence this money should firstly come was partly answered by the late Senator Norbeck, of South Dakota, who took the trouble to draft in preliminary form a bill providing for the planned development which he unqualifiedly favored. The plans, too, had the commendation of Mrs. Anna Wilmarth Ickes, who wrote the fine book "Mesa Land."

Meanwhile the visitor to the Black Hills is warned that without this development he can at present see next to nothing aside from fine "Rim" scenery at the monument, unless he is an extremely well-read and trained geologist. Above all, he need not go there, as many have done, expecting to quickly find and take away valuable specimens. Except for some mere accidental fragment meaningless to the layman, nothing is to be seen at the surface fulfilling the untrained conception of petrified forests.

G. R. WIELAND

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BUILT-UP FILMS OF PROTEINS AND THEIR PROPERTIES

RECENTLY, Irving Langmuir, V. J. Schaefer and D. M. Wrinch[1] published in this journal experiments in which protein monolayers were deposited on chromium-plated slides, which were covered with several layers of barium stearate. By this procedure it was possible to build up several layers of protein films, which, depending on the method used, had either their lyophobic groups ("B" layer) or their lyophilic groups ("A" layer) exposed to the surface. From these experiments the following appear to be noteworthy and apparently open to objections:

(1) The protein layers were built up from films which were spread on distilled water and compressed to a pressure of 30 dynes per cm. (2) Lyophobic B-layers are wetted by water to the same extent as lyophilic A-layers. (3) PRBB layers can be obtained by suitable procedures, whereas it was impossible to build up PRAA layers.

According to Gorter,[2] Hughes and Rideal[3] and to my

[1] SCIENCE, 85: 76, 1937.
[2] *Proc. Acad. Sci. Amsterdam*, 29: 371, 1926.
[3] *Proc. Roy. Soc.*, 137A: 62, 1932.

own experience[4] homogeneous films can be obtained when proteins are spread on a salt solution having the P_H of the isoelectric point of the protein in question (egg albumin P_H4.8). In no instance was it possible to obtain homogenous films—as observed through the ultramicroscope—on a surface of distilled water. Likewise, at salt solutions of P_H3 or P_H7 the protein films contained signs of inhomogeneities. It has been found also that films of egg albumen start to collapse at a pressure of about 18 dynes per cm.

In the light of these observations it seems to be possible that in those cases in which protein layers were built up from films which were spread on distilled water, and compressed to 30 dynes per cm, Langmuir, Schaefer and Wrinch were dealing with inhomogenous and collapsed films whose surfaces were to some extent both lyophilic and lyophobic. This would explain the observation that A and B layers are wetted equally by water and by lyophobic solvents, respectively.

Whereas it was not possible to build up PRAA.. films, it is surprising that the authors were able to build up PRBB... layers. In both PRAA.. and PRBB. . layers the lyophilic $-NH_3^+$ and $-COO^-$ groups of one layer would be attached to the lyophobic paraffin groups of the neighboring layer. On theoretical reasons these groups should exert relatively weak cohesive forces upon each other (ion-induced dipole) which probably could be overcome easily by the attractive forces between water and the lyophilic groups (ion-dipole) when such a polylayer is dipped into water. That the polar groups of proteins do not interact with lyophobic groups of other molecules has been suggested by experiments of the author—to be published shortly—in which the molecules of a mixed protein—fatty acid film occupy apparently the same area which they occupy when the compounds are spread alone. The question arises, therefore, whether or not the PRBB layers likewise consist of inhomogenous protein layers which to some extent are both lyophobic and lyophilic.

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A REAGENT FOR VITAMIN B_1

A PRELIMINARY report by McCollum and Prebluda[1] on a reagent for the detection and estimation of vitamin B_1 prompts me to send this note on a reagent for vitamin B_1 which I have been investigating for some time.

An investigation recently completed, and soon to be published, showed that the thiazoles form with potassium iodide a sensitive reagent for the detection of bismuth and antimony. It was also shown that a solution of bismuth iodide in potassium iodide is a sensitive reagent for thiazoles. Since Williams, Clark and coworkers have shown that vitamin B_1 contains a thiazole fraction, it was suggested by Dr. Benjamin Harrow, of these laboratories, that bismuth potassium iodide be tested as a reagent for vitamin B_1.

This research was begun and a characteristic orange-red precipitate was obtained with the reagent and the following vitamin B_1 products: Fleischmann's yeast cakes, Squibb's malted wheat germ extract (vitavose) and Squibb's vitamin B and G syrup. Fresh orange juice, fresh grapefruit juice and canned tomato juice also gave a characteristic precipitate with the reagent. Certain brands of canned orange juice and canned grapefruit juice did not give the reaction. These products, when treated to destroy the vitamin, gave no precipitate with the reagent unless care was taken to preserve the thiazole nucleus.

The orange-red precipitate formed by the reagent with the above-mentioned products can be filtered, dried and weighed. The weight of the precipitate was found to be proportional to the amount of product used.

This work is being extended further, and complete details will be published later.

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THE EFFECT OF TEMPERATURE UPON THE RESPONSES OF PLANTS TO PHOTOPERIOD[1]

To furnish material for further studies of the relation of anatomical condition to blossoming,[2,3] more than 100 varieties of plants, including some monocotyledons, are being grown in different environmental and cultural conditions. The principal variables being used are photoperiod and temperature, although some partial defoliation, girdling, shading and low nitrogen treatments are also included. It appears that temperatures a little above or below the usual range employed in greenhouse culture have been effective in altering the responses of some plants which are commonly considered to have a fixed or definite reaction to relative length of daylight. For instance, poinsettia plants grown in the short days of winter at a temperature of 68° to 70° F. remained strongly vegetative and did not blossom, while plants in temperatures of 60° to 65° blossomed normally and plants in temperatures of

[4] *Jour. Phys. Chem.*, 40: 361, 1936.

[1] SCIENCE, 84: 488, November 27, 1936.

[1] Published with the permission of the director of the Wisconsin Agricultural Experiment Station.

[2] Ocra C. Wilton and R. H. Roberts, *Bot. Gaz.*, 98: 45-64, illus., 1936.

[3] R. H. Roberts and Ocra C. Wilton, SCIENCE, 84: 391-392, 1936.

55° to 57° show only slight tendencies to blossom (January 25). Plants which were moved from 63° (average), after forming blossom buds, to 70° abscissed their flower clusters. Large percentages of the poinsettia plants grown in long days at temperatures of 55° to 57° are producing blossoms. A similar departure from the usual responses to photoperiod occurred in the case of Klondyke cosmos. In previous years *Rudbeckia* plants have never produced stems when in short days but only a rosette of leaves. The plants in a cooler temperature this season are producing typical stems. These show no tendency to produce blossom buds, however; the plants in long days at cool temperature are forming abortive blossoms.

Other plants which have had their customary responses to photoperiod altered by temperature effects are: alfalfa (seed setting), winter barley, castor beans, wax beans, Chinese cabbage, chrysanthemum, white clover, geranium, hemp, Jimson weed, lettuce, pansy, pigweed, spring rye, spinach, stock, timothy and spring wheat.

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SCIENTIFIC BOOKS

THE LUNG

The Lung. By WILLIAM SNOW MILLER. Charles C. Thomas. Baltimore, 1936. 209 pages. $7.50.

THE many friends and students of Dr. William Snow Miller will be delighted at the appearance of his book, "The Lung." Many have urged that he put into book form the knowledge gained from his long study of the anatomy of this organ. Some years ago the Committee on Medical Research of the National Tuberculosis Association provided funds with the hope that he could see his way clear to doing it. More recently Dr. Lawrason Brown gathered among Dr. Miller's friends funds for the same purpose. Now that it has come, it is beautifully illustrated and full of a wealth of knowledge.

Dr. Miller, as a great anatomist and no less keen historian, has combined these two talents in his book. Possibly the title, "The Lung," is a little too comprehensive, as the volume deals only with the anatomy, histology and architecture of the lung, and not with its living function. Nevertheless, the volume will do much to enable students to understand the fineness and delicacy of an organ which is difficult to visualize in detail.

All those students who have worked with Dr. Miller in his laboratory will miss in the photographs the depth and contrast made possible by the study of his actual models, which are such artistic pieces of work. They will not lack in understanding of the long, patient study of the structure of the lung, which he made by serial section, microscopic study, camera lucida drawings on scale paper to give exact proportions, for they will have seen Dr. Miller at work before finally completing his model with each system colored differently and checked against the serial sections. The skill with which these models have been conceived and executed have done what the author wished them to do—cleared up many vexed questions in lung and vascular architecture and lung function.

One very notable feature of Dr. Miller's work has been his ability to draw upon pathological material to illustrate many of the questions rendered difficult by histological methods alone. In particular is this true in determining the presence of an alveolar epithelial lining. This was accomplished by studying exudates in inflammatory conditions occurring between the basal membrane and covering cells of the alveoli, thus making clear the continuous epithelial covering.

Dr. Miller's work demonstrating the valves of the lymphatic system, which forces the flow in the lymphatics always in one direction, has always been helpful in understanding many pathological conditions. The different currents of the lymphatic flow in pleura and lung and his intimate study of elastic tissue layers has been invaluable also in understanding many pathological conditions.

The problem of anastomosis between the branches of the aortic system and pulmonary artery system Dr. Miller has also clarified. According to Dr. Miller's view, this probably only occurs in the capillary part of the two systems. The question of different blood supply to lymphatic tissue in different animals—for instance, by the bronchial artery in the rabbit and by the pulmonary artery in the guinea pig—probably explains in part the different distribution of tuberculosis in this disease in the two animals.

It would make too long a review to call attention to other interesting structures. It is possible that the book is too technical for many, but every student of anatomy and every clinician should have it for reference and should from time to time study it to clarify his picture of the fineness of this organ.

The historical division of this book every one interested in medical history will find delightful reading, but one thing is sure, that every one who has known Dr. Miller and his lifelong study in this field will be gratified that his knowledge has been put in such a satisfactory volume.

WM. CHARLES WHITE

NUCLEAR PHYSICS

Elements of Nuclear Physics. By F. RASETTI. New York: Prentice-Hall, Inc. $4.50.

WITH the publication of this and other books of the past year, the term "nuclear physics" may be regarded as having been officially admitted to the language. "Nuclear chemistry" seemed likely, for a time, to take the lead. Perhaps it would have been more appropriate on the whole, since a large part of the subject consists in reactions of transmutation for which the symbolism of chemistry is admirably fitted, and another part consists in measurement of the masses of atoms; but after all, almost the whole of the subject is a gift of the methods of physics to the sum of knowledge, and it would certainly ill beseem a physicist to complain.

Professor Rasetti, now of the University of Rome, was known as a notable experimental physicist even years before he belonged to the group at Rome which, with Fermi at their head, investigated transmutation by neutrons on a grand scale and discovered the enhanced transmuting power of slow neutrons, as well as much else. He is a familiar figure in this country, both in East and West. His English as exhibited in this book is flawless, though the style is dry and austere, largely because of the extreme condensation; for the book is packed with information, and scarcely a word is dispensable.

First (after a brief introduction) we find an account of the apparatus used for detection of fast-moving charged particles. Then come two chapters on what was formerly called "radioactivity" *tout court,* but must now be called "natural radioactivity"; taken together, they give a better share of the book to natural radioactivity than is frequently given nowadays, when so many writers are in haste to get to phenomena of newer interest. The latter of the chapters contains an account of alpha, beta and gamma ray spectra and of the Gurney-Condon-Gamow theory of the alpha-particle emission. Between them is inserted a long section concerning the interactions of alpha, beta and gamma rays with the atoms which they traverse or the electrons near which they pass, and including the creation and "annihilation" of electron-pairs (why must people speak of electrons being "annihilated" when their mass and energy go over into equal mass and energy of light?) Future classifiers of physics may take these topics out of nuclear physics altogether; for the present, it is relevant to insert them. Next come the tabulations of the masses and spins of the nuclei, with an exceedingly brief outline of the ways of measuring them. Next come two chapters on transmutation—an unexpectedly small share of the book! A considerable number of reactions are quoted, and there is a table of artificial radioactive substances. The book ends with a very concise account of cosmic rays.

The book is definitely an advanced text; students of the experimental side may find that all they require is the power of concentrated attention, but for the theoretical parts a grounding in quantum mechanics is needed. Readers already having some knowledge of the earlier stages of quantum theory will be glad to find the theories of scattering (after Born) and of penetration of potential barriers expounded without these usual preliminaries; and there is a good outline of the Heisenberg and Majorana theories of intra-nuclear interactions, and of the present state of the theory of the energy-loss suffered by fast electrons as they progress through matter. The author withstood too well the usual temptation of authors to lay undue stress on their own researches; one would like a fuller account of the work of the Roman school. The part about the Compton effect must have been written just too early to include the recent tests of the simultaneity of the recoils of electron and photon. The list of the naturally radioactive elements excludes all of atomic number less than 81, but for potassium, rubidium and samarium; it is not clear whether this represents a definitely adverse judgment of the author as to claims recently made for other elements.

KARL K. DARROW

SPECIAL ARTICLES

STUDIES ON THE PRODUCTION OF ANTIBODIES IN VITRO

IN 1912, Carrel and Ingebrigtsen[1] cultivated the bone marrow and lymph glands of guinea pigs in homologous blood plasma to which were added small amounts of red cells from the goat. On the fifth day, the culture fluid hemolyzed red cells from the goat without the addition of complement. After being heated at 56° C., the culture fluid lost its hemolytic power. Then, by addition of complement, this lost power was regained. On the basis of these and other tests, it was concluded that immune hemolysins had been formed. Since that time, numerous investigators have employed this direct method of adding the antigen to the tissue at the time of explantation. Some have reported positive results, others negative. A quite recent paper by Salle and McOmie[2] records negative findings in experiments in which chick embryonic tissue and rabbit or guinea pig spleen and lung were

[1] A. Carrel and R. Ingebrigtsen, *Jour. Exp. Med.,* 15: 287, 1912.

[2] A. J. Salle and W. A. McOmie, *Jour. Immunol.,* 32: 157, 1937. (Extensive bibliography.)

cultivated in media containing heterologous sera or foreign red cells.

Still other investigators have worked with tissues taken from animals that were injected with the antigen before explantation. Lüdke[3] injected killed cultures of typhoid bacilli into rabbits and guinea pigs, removed fragments of the spleen and whole femur after from 24 to 60 hours and incubated them in various culture media. After from 2 to 5 days, he was able to detect agglutinins in extracts prepared from the spleen and bone marrow. Przygode,[4] Reiter[5] and Meyer and Loewenthal[6] have also reported antibody production in tissues removed after injection of the animal. In contrast, however, similar attempts by Kuczynski, Tenenbaum and Werthemann[7] were unsuccessful. The experiments described in this paper were undertaken to reinvestigate the problem, utilizing recent improvements in the tissue culture techniques.

Fragments of adult rabbit spleen removed from animals injected 2 and 3 days previously with washed guinea pig red cells were found to produce easily demonstrable agglutinins against guinea pig red cells after 4 days' incubation in a fluid medium. The medium consisted of 3 parts "normal" rabbit serum, 1 part isotonic sodium bicarbonate (1.4 per cent.), 2 parts Tyrode's solution containing 4 times the usual amount of glucose, and 0.005 per cent. phenol red to serve as an indicator. For each culture, approximately 100 mg of tissue (75 fragments) were suspended in 2 cc of medium contained in H-8 Carrel flasks. These flasks have a total capacity of about 70 cc. In addition to the fluid medium, each culture was supplied daily with an atmosphere consisting of 80 per cent. O_2, 8 per cent. CO_2 and 12 per cent. N_2. The high concentration of O_2 is necessary in order to keep the fragments alive. The CO_2 acts together with the rest of the medium to keep the pH constant at 7.2. This method of cultivation[8] makes for functional survival of the tissue fragments without any marked proliferation of the constituent elements.

The serum in which the tissues were cultivated was usually taken from one or more untreated rabbits that had previously been found to contain at most mere traces of natural agglutinating antibodies against guinea pig red cells. But occasional use was made also of autologous serum taken from the injected animal at the time the spleen was removed. As controls, all culture media were incubated without tissue for the period of the experiment. Additional controls consisted of duplicate cultures kept at 4° C. Ordinarily, all these yielded negative tests, whereas hemagglutinins produced by the tissues were detected in the culture fluid in various dilutions sometimes as high as 1:320. Furthermore, no increase in antibody output was ever obtained by using serum from animals whose spleens had previously been found to produce antibodies in more than moderate amount.

Under the same conditions of cultivation, adult rabbit spleens taken from animals injected 1 to 24 hours previously with washed guinea pig red cells failed to produce demonstrable antibodies. This indicated the possibility that the production of antibodies outside the body may be dependent upon certain reactions occurring within the organism and that these reactions must reach a certain stage before the process can readily be completed *in vitro*.

Negative results were obtained also when spleens taken from animals injected 24 hours previously were cultivated in the sera of rabbits injected three days previously with a proportionate amount of the same antigen. This was true even when the serum in which they were cultivated had been taken from animals whose spleens had produced demonstrable antibodies in dilutions as high as 1:256 and 1:320 when cultivated in normal serum. It appears then that if the serum of an animal injected three days previously contained certain necessary substances not present after one day, these substances were incapable of acting together with tissues that had not undergone the same period of preparation.

Next, an attempt was made to shorten this period by first injecting a bacterial antigen (*V. metchnikovi*), followed several days later by the washed guinea pig red cells. But when the spleens were removed for cultivation 24 hours after the last injection, they still failed to produce agglutinins against the foreign red cells.

Other experiments were made in which the spleen was perfused with the antigen by injecting it directly with the foreign red cells by way of the splenic artery. After from five to ten minutes, the spleen was removed and cultivated in the usual manner. Again, the results were negative.

Interesting observations were made also in the matter of animal individuality. When sera from different animals were used in the cultivation of tissues taken from a single organ, some proved to be excellent culture media, whereas others were decidedly toxic. It was found also that tissues removed from different animals that had been injected previously with proportionate amounts of the same antigen may, upon cultivation in a given sample of serum, remain in an equally good state of preservation and yet differ in antibody response.

[3] H. Lüdke, *Berl. klin. Woch.*, 49: 1034, 1912.
[4] P. Przygode, *Wien. klin. Woch.*, 26: 841, 1913.
[5] H. Reiter, *Z. Immunitätsforsch.*, 18: 5, 1913.
[6] K. Meyer and H. Loewenthal, *Z. Immunitätsforsch.*, 54: 420, 1928.
[7] M. H. Kuczynski, E. Tenenbaum and A. Werthemann, *Virchows Arch. path. Anat.*, 258: 687, 1925.
[8] R. C. Parker, SCIENCE, 83: 579, 1936.

Some of the experiments reported above were also performed using bacterial antigens. The results were similar to those obtained when foreign red cells were used.

Finally, attempts were made to repeat the experiments of Meyer and Loewenthal,[6] who reported antibody production in hanging drop cultures of spleen taken from rabbits injected one hour previously with bacterial antigens. Although all the older procedures were carefully adhered to, the results were entirely negative.

In view of the positive results obtained when the antigen was allowed to remain for two to three days in the animal, the negative results obtained when this period was shortened have a very definite significance. They not only suggest that antibody production is a more complicated process than is usually assumed, but they imply that it is not easy to demonstrate a production of antibodies *in vitro* unless the tissues have first been acted upon by some unknown mechanism within the body.

All the serological tests in the course of these experiments were made under the supervision of Dr. Karl Landsteiner, upon whose experience the plan of investigation was entirely dependent.

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PREPARATION OF AN ACTIVE AGENT FROM INACTIVE TUMOR EXTRACTS

THE majority of fowl tumors of spontaneous origin which have been transplanted have proved to be transmissible by cell-free filtrates or desiccates of the tumors. On the other hand, chemically induced fowl tumors, with the exception of three reported by MacIntosh,[1] are transferable only by grafts of living tumor cells. In this respect the latter resemble the mammalian tumors. It has been shown in this laboratory that not infrequently the low activity of filtrates or desiccates, occasionally encountered in transmitting the filterable tumors, is due to the presence of an inhibiting factor rather than the absence of the agent. This was established by the fact that the removal of the inhibitor by adsorption on alumina gel rendered the extract highly active in tumor production.[2] However, this method failed to explain the non-filtration of a slow-growing fibro-sarcoma (Chicken Tumor 10) which has been under observation in this laboratory for the past ten years. A strong inhibitor has been shown to be present in this tumor by cross tests with Chicken Tumor I, but treatment of extracts with alumina g failed to render the extracts active in the transmissi of the tumor. Yet there was a suggestion that t tumor possessed a transmissible agent from the fa that once or twice tumors resulted from injection desiccates, but this was a rare occurrence and the was no clear-cut transmission by filtrate in the ma attempts which have been made.

In recent studies of Chicken Tumor I, it has be shown that the agent could be sedimented by hig speed centrifugation, and this method seemed clear to separate the agent from its own inhibitor.[3] Th observation suggested a further attempt to transm the fibro-sarcoma.

Experiment: A water extract was prepared from a eight-week old Chicken Tumor 10 and the extrac passed through a Berkefeld V candle. The filtrat was submitted to a centrifugal force of 14,000 time that of gravity for 2½ hours. The resultant sedimen was taken up in Tyrode's solution and redeposited a high speed. This washed sediment was next suspende in a volume of Tyrode's equal to 1/10 that of the orig nal filtrate. For activity tests, 0.4 cc of the suspensio were injected into normal hens, the same birds als receiving the same amount of the original filtrate i another area for control. No tumors developed as th result of injection of the unspun filtrate. Tumors di arise in 50 per cent. of the areas injected with th washed sediment, reaching a size of 3.1 × 2.3 cm within 40 days. Later some of them retrogressed. The his-tology of the original tumor was duplicated in th induced tumors.

In a second experiment an extract was prepared from a desiccate of Chicken Tumor 10, and this extract was treated in the same manner as that described above. Again the unspun extract gave negative results, while the injection of the washed sediment resulted in 33 per cent. positive results.

That the production of tumors in these experiments was not simply an effect of concentration of the agent was shown by the following test. The supernatant fluid, depleted of the agent, was saved. Part of the sediment, after being washed and resuspended in Tyrode's solution, was mixed with an equal volume of the original supernatant fluid. The remaining sediment was diluted to the same degree with water as a control. The injection of the diluted sediment gave positive results in 50 per cent. of the areas injected, while the part diluted with the original supernatant fluid failed to induce tumors in any of the areas injected.

The complete neutralization of the active sediment by its own supernatant fluid indicates that the failure

[1] J. McIntosh, *Brit. Jour. Exp. Med.*, 14: 422, 1933.

[2] Jas. B. Murphy, O. M. Helmer, A. Claude and E. Sturm, SCIENCE, 73: 266, 1931.

[3] A. Claude, paper in press.

the original extracts to produce tumors was due to e presence of inhibitory elements in the solution. he fact that agent and inhibitor can be separated by ysical means would suggest either that the agent is ot modified by its inhibitor or that the reaction be- een them is easily reversible. Whether or not this ntrifugation method will separate potent agents om hitherto non-filterable tumors will be determined further tests. So far, preliminary experiments with ammalian tumors have given negative results.

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THE FEEDING OF HOLLOW-SPEAR NEMATODES ON OTHER NEMATODES[1]

THE habit of preying upon nematodes has been ound by the writers to be well developed in two roups of nematodes in which it appears not to have en recorded: the genus *Aphelenchoides* Fischer, 94, and the dorylaim genera *Dorylaimus* Dujardin, 45, *Discolaimus* Cobb, 1913, and *Actinolaimus* Cobb, 913. Equipped with hollow, protrustive oral spears stylets, predators of these genera feed, not as do e types formerly recognized as feeding on nema- odes, but rather by inserting their spears into their rey and holding them there while sucking out the ody contents. The relatively large dorylaims, with eir coarse spears and powerfully muscular esoph- guses, disorganize their prey so quickly that there little opportunity for struggle. The rather small phelenchoides, on the contrary, feed slowly, and here e evidence is definite for one species that the prey paralyzed almost instantly when the very slender tylet is inserted, so that struggles are prevented. uring the feeding of two species of Aphelenchoides, aliva has been seen flowing out from the large dorsal sophageal gland, through the esophageal tube and nto the prey.

Soil-inhabiting nematodes formerly recognized to e predacious on other nematodes, such as species of *Mononchus* Bastian, 1865, and *Diplogaster vorax* Goodey, 1929, are equipped with fine grasping teeth, ith cutting teeth or with both. Slender mural teeth hich slash into prey but are withdrawn while feed- g are possessed by the genera *Nygolaimus* Cobb, 913, and *Sectonema* Thorne, 1930, which are known rom the work of Thorne[2] to prey upon oligochaet orms. Cobb,[3] in listing 16 genera of predacious ree-living nematodes, most of which are marine orms, mentioned "Pharynx with acute clutching organs—onchia or denticles" as characteristic of such genera. Of these genera, only *Dorylaimus* feeds through a hollow oral spear.

Dorylaimus was included in Cobb's list of carnivorous forms, despite its lack of clutching organs, on the strength of his simultaneously published record of two nemas of this genus feeding upon mite eggs; of Steiner's[4] earlier record of a seta of an oligochaet worm in the intestine of *Dorylaimus regius* de Man, 1884; and of Thorne's[5] finding three instances of *Heterodera schachtii* Schmidt eggs impaled on the spears of young *Dorylaimus obtusicaudatus*.

We have repeatedly observed various species of this genus and allied genera, including larvae and adults of both sexes, feeding upon other nematodes including larvae of *Heterodera marioni* (Cornu) Goodey, 1932. All these observations, with two minor exceptions, have been in Petri dishes of agar. Unlike predators capable of grasping or slashing their prey, these forms which suck their food through hollow spears seem unable to capture prey suspended in water, for considerable pressure is required to thrust their relatively coarse, hollow spears into other nematodes. Even a very soft agar is unsatisfactory, the prey being pushed through the medium by the spear instead of being penetrated.

A predacious dorylaim finds its prey only by chance, but when its head makes contact with another nematode it responds immediately. It orients its head at right angles with the surface of the prey, so that its lips make firm contact, then protrudes its spear suddenly in an attempt to penetrate, and may do so repeatedly if not immediately successful. Once the spear enters the body of the prey it is held there while the heavily muscular esophagus of the predator begins a rhythmical sucking action which quickly disorganizes the body contents of the prey, sucking them out and leaving an empty, collapsed body wall.

A dorylaim holds its spear extended far into its prey, even during the periods of rest which alternate with periods of sucking. With a medium to large dorylaim, the spear tip reaches to the opposite body wall of such nematodes as the larvae of *H. marioni*. Such a position is advantageous in view of the long diagonally placed opening on the side of the spear.

Some of these predators have also been seen feeding on nematode eggs, both of *H. marioni* and of various free-living forms. When egg masses of the former are placed in agar dishes they prove most attractive to at least some of these species.

The predators in question have not yet been identified specifically, but it is our judgment that ten species of *Dorylaimus*, two of *Discolaimus* and one of *Ac-*

[1] Published with the approval of the director as Technical Paper No. 97 of the Pineapple Experiment Station, University of Hawaii.

[2] G. Thorne, *Jour. Agr. Research*, 41: 445–466, 1930.

[3] N. A. Cobb, *Jour. Parasitology*, 15: 284–285, 1929.

[4] G. Steiner, *Jour. Agr. Research*, 28: 1062–1064, 1924.

[5] G. Thorne, *Jour. Agr. Research*, 37: 575, 1928.

tinolaimus are now represented in our collection of individuals which have been preserved after having been seen feeding on other nematodes. These represent collections from pineapple fields, gardens, wet forest and arid waste land on the island of Oahu and from association with weed roots from Christmas Island, a small coral atoll lying at 21° 57′ N., 157° 27′ W. Further details with specific identifications will be reported later.

From observations on their occurrence in Hawaiian pineapple fields it appears that these dorylaims are vastly more important as predators than species of *Mononchus*. Cassidy[6] reported four species of that genus from pineapple field soils, but these are very rare. The dorylaim genera *Dorylaimus* and *Discolaimus*, on the contrary, are generally present and often numerous. For instance, a sample of 252 grams soil with 46 grams roots from under a single pineapple plant contained dorylaims of two species at the rate of 1.3 per gram, but no specimen of *Mononchus* was found.

The predacious species of *Aphelenchoides* are more remarkable in several ways, being morphologically very similar to several plant-parasitic species and being members of a group in which no predacious tendencies seem to have been suspected. The genus includes species parasitic on higher plants as well as at least one fungus-sucking species.[7] Some other species are free-living forms of unknown food preference but commonly regarded as saprophytic.

We have found two species of this genus to be highly specialized predators which, given a sufficient population of prey, multiply rapidly in agar culture. Both are cultured readily by transferring them to cultures of *Aphelenchus avenae* Bastian, 1865, or *Aphelenchoides parietinus* (Bastian) Steiner, 1932, previously established in an agar culture of a suitable fungus. Neither predator feeds on fungi.

One of these species appears to be *Aphelenchoides tenuicaudatus* (de Man, 1895) Goodey, 1933, while the other may require description as a new species. Both have very slender hollow stylets, with which they penetrate their prey and through which their food is drawn. *A. tenuicaudatus* attacks nematode eggs as well as larvae and adults, while the other appears to feed only on nematodes.

These two predators are both small, well under one millimeter in length, but they attack successfully larvae of *H. marioni* and both adults and larvae of *Anguillulina pratensis* (de Man) Goffart, 1929, as well as of various free-living species including forms larger than themselves. Both species appear to exert a paralyzing action on their prey, which helps to compensate for their inferior size, for nematodes penetrated by the stylet become inactive almost immediately and lie still during the relatively slow process of being sucked out.

Paralysis of prey was clearly indicated for the undescribed species of *Aphelenchoides* when a larva only one hour old was seen to pierce an *A. avenae* twice its own length. This prey was moving rapidly at the time, so that the predator lost its hold and its stylet was within the prey for only an instant; still this nematode stopped in half its own length and lay quiet for several hours before being fed upon by another predator.

Such paralysis probably results from an injection of saliva from the predator. No injection at the instant of penetration has been seen, but repeated salivary injection during feeding has been observed in many instances with both species of *Aphelenchoides*. The saliva itself has come from the dorsal esophageal gland, which is highly developed in this genus.

During periods of active sucking and continuing into the many alternating periods when the esophageal bulb is at rest, saliva may be seen flowing anteriorly from the long dorsal esophageal gland, through a slender noncuticular duct dorsad of the intestine, and into the posterior end of the esophageal bulb dorsad of its lumen. Here the duct widens, and the saliva is seen to continue its anterior flow within the confines of the bulb but dorsad of its cuticular crescentic plates, and to enter the anterior nonstriated part of the bulb. In both species this part is distinctly alveolate, and into its cavities the saliva flows. Accumulation here is apparent while the muscular part of the bulb is at rest. This alveolate region may be seen to twitch irregularly as it fills, and after it is filled some return flow from it posteriorly towards the dorsal gland often occurs.

As soon as the muscular bulb resumes activity saliva again flows anteriorly from the dorsal gland. Presumably some of this saliva enters the lumen of the esophagus and mixes with the food rushing posteriorly towards the intestine. Very clearly, however, during momentary interruptions of the inflow of food, some of it rushes anteriorly from the bulb through the lumen of the esophagus and stylet and into the body of the prey where it appears to start the process of digestion. These details have been observed repeatedly in both predacious species of *Aphelenchoides*.

These observations of saliva flow lend great weight to the hypotheses of various investigators to the effect that pathological states arising from nematode infestations result, at least in part, from an outpouring of salivary secretions.

[6] G. Cassidy, *Hawaiian Planters' Record*, 35: 305–339, 1931.

[7] J. R. Christie and C. H. Arndt, *Phytopathology*, 26: 698–701, 1936.

After this note was submitted for publication, Mr. Gerald Thorne, of the United States Bureau of Plant Industry, who was sent a manuscript copy, wrote as follows (personal communication): "There are many species of *Discolaimus* and *Actinolaimus* in my collections . . . which I know to be predacious. But it was only about a month ago that Mr. McBeth . . . saw our first *Aphelenchoides* feeding on another nema."

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A CIRCULATION PUMP[1]

IN a series of experiments on adrenaline secretion[2] need arose for a pump with which to pump the blood from the adrenals of a cat into its carotid artery. A description of the main features of this pump, which has been found to function satisfactorily and which can be used for the perfusion of organs with blood or other fluids or for the maintenance of the circulation of a whole animal, follows.

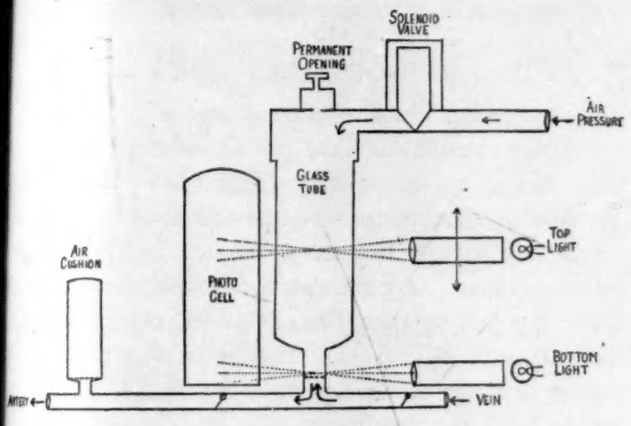

FIG. 1

The blood, leaving the vein, enters a vertical glass-tube. Its top is connected with the outlet of a solenoid air-valve, the inlet of which leads to an air-cylinder. When this valve is opened, the pressure, delivered by the tank, acts on the blood in the glass-tube and pumps it out. Two glass-valves direct the blood from the tube into the artery during the systole and prevent back flow from the latter during the diastole of the pump. When the glass-tube is emptied the air-valve is closed, and new blood is thus allowed to enter.

The air-valve is opened and closed by a photo-electric cell activated by two beams from two light sources, which pass through the glass-tube and can be interrupted by the blood column. These light-beams are focussed by lenses in such a manner that one passes through the bottom of the tube, while the other one is focussed on it at any desired height above. The wiring of the relay-contacts of the photo-electric outfit, the solenoid valve and the light sources result in the following operations of the pump. During systole the air-valve is opened and the top-light is out. Air pressure pumps the blood out of the tube into the artery until the blood column reaches the beam of the bottom-light. This beam is thus allowed to pass through the glass-tube and activates the photo-cell, which then closes the air-valve and switches the top-light on. During the ensuing diastole the top-light keeps the solenoid-valve closed until the rising blood level cuts the light off the photo-cell, which, by opening the pressure valve and switching the top-light off, starts the next systole. A narrow permanent opening at the top of the glass-tube allows the blood to replace the air enclosed in the tube during the diastole.

The output per stroke is determined by the height at which the top-light-beam passes the glass-tube. With each stroke, the tube is emptied, since the lower beam passes through the lowest part of the glass-tube. Increase or decrease in venous return are answered by a corresponding change in rate. The desired systolic pressure is adjusted by the reduction valve at the pressure tank. A large inside diameter of the glass-tube prevents significant changes in venous pressure, as small changes in level correspond to large changes in volume. An air-cushion chamber as used in other circulation pumps between arterial valve and artery maintains blood flow and pressure during the diastole. By placing the lower end of the glass-tube below the level of the vein, a slight suction may be obtained, which facilitates venous return. The parts of the pump which are placed close to the animal in order to avoid dead space in the connections between pump and vessels are: the two flow-valves, glass-tube, which by means of a metal fitting is screwed into the bottom of the air-valve, the two light-bulbs with lenses and the photo-electric cell (see Fig. 1). These parts are mounted on a metal holder and connected with the rest of the set-up by cables. All parts conducting blood can be heated electrically. They may also be kept sterile. We have used the pump with a maximum speed of about 100 strokes per minute, although usually a lower rate was preferred.

This pump resembles the artificial heart of O. S. Gibbs,[3] as with a constant, but adjustable output per stroke its output per minute depends on the venous return. Unlike the Gibbs-pump it avoids the contact of rubber with the blood. All the major parts used

[1] Aided by a grant from the David Trautman Schwartz Research Fund.

[2] Gerhard Katz and Gertrud Katz, *Jour. Pharm. and Exp. Therap.* (in press).

[3] O. S. Gibbs, *Jour. Pharm. and Exp. Therap.*, 38: 197.

are commercially available and comparatively inexpensive.

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A NEW TECHNIQUE FOR THE STUDY OF DROSOPHILA EGGS AND LARVAE

WHILE carrying on hybridization experiments on two subspecies of *Drosophila virilis* it was suggested to the writer by Dr. A. H. Sturtevant that egg counts be made. In attempting to improve on the present technique of egg collection it was discovered that a fly will readily deposit her eggs through cloth mesh onto the proper medium. To make use of this fact

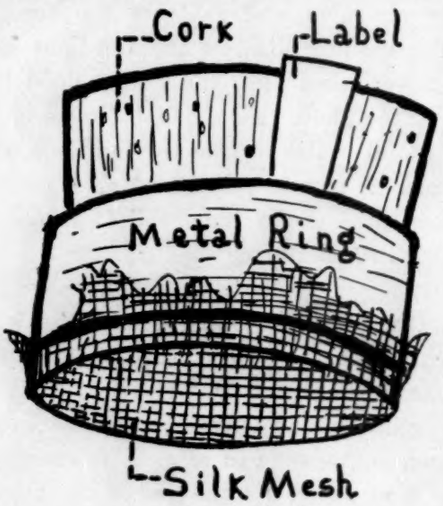

FIG. 1

the apparatus shown in the figure was devised. It is a tiny Drosophila cage, consisting of a metal gas-hole ferrule or ring $\frac{7}{8}$ inch in diameter and $\frac{1}{2}$ inch high. Over one end of this ring is stretched tightly a piece of black silk bobbinette, trade No. 400 for large species of Drosophila and No. 418 for small species. This silk net is held in place by a rubber band. Into the smaller end of the ring fits a cork of such a size that it projects part way into the ring. The label may be written on a small slip of library card which fits between cork and ring. This ensures a sufficient air supply.

In most experiments one female per cage is used. For securing eggs the cage is placed directly on the medium and the fly lays her eggs through the silk mesh. Few if any eggs stick to the mesh, and these may be seen against the black background. The medium of corn-meal molasses agar or banana agar with a little animal charcoal added for contrast is poured into a small waterproof paper plate of a size conveniently examined on the stage of the binocular. Yeasting is done by spraying a fine suspension from an atomizer onto the plate shortly before using. The medium should contain an extra supply of agar to ensure stiffness and to keep the silk from getting wet.

Several experimental cages may be placed on the same plate. To guard against contamination an inverted paper plate covers the apparatus and is held in place by paper clips or rubber bands. After a given time the cages are lifted off and transferred to a fresh agar plate. The egg output of each female is then counted. If the experiment calls for the rearing of larvae a piece of the medium containing a certain number of eggs is cut off and placed with food in a culture vial or bottle. The agar plate may then be covered, and from time to time egg hatching and early larval stages examined directly under the binocular.

This apparatus has advantages in the collection of large numbers of eggs and larvae, life history studies and various problems dealing with the rearing of Drosophila. Its use facilitates the introduction of quantitative methods.

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THE EAR-OSSICLES IN CRANIA

IN removing crania, human, or other, from fossil areas, the ear-ossicles have not been looked for in the surrounding earth, or still within the cranium. But in handling the temporal bone the ossicles may fall out unless cotton at once be placed in the external auditory canal. By such care a stapes was recovered from the left temporal of Lake Pelican man, Otter Tail County, Minnesota. This is an appeal to excavators to place cotton in ear-hole at once, and to examine earth for specimens.

THOMAS HORACE EVANS

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PEARSON, THOMAS G. *Adventures in Bird Protection; An Autobiography.* Pp. xiv + 459. 11 plates. Appleton-Century. $3.50.

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Report of the First Scientific Expedition to Manchoukuo under the Leadership of Shigeyasu Tokunaga. June–October, 1933. Section IV, Part III, Myxomycetes of Jehol. Pp. 55. 161 figures. 1 plate. *Section IV, Part IV, Index Florae Jeholensis.* Pp. 108. 3 plates. *Section V, Division I, Part X, Article 38–52, Insects of Jehol (VI).* Pp. 143. 20 plates. *Section VI, Part II, Palaeolithic Artifacts Excavated at Ho-Chia-Kou in Ku-Hsiang-Tung, Manchoukuo.* Pp. 107. 53 figures. 26 plates. Faculty of Science and Engineering, Waseda University, Tokyo.

THOMAS, WILLIAM I. *Primitive Behavior.* Pp. ix + 847. 10 figures. McGraw-Hill. $5.00.

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